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(54) Mechanical counter for a metering apparatus

(57) A metering apparatus for metering for example a medicament requires a device with which the number of metering portions is displayed. The known display devices however are not suitable for a metering apparatus having two housing portions which are rotatable relative to each other. The mechanical counter for a metering apparatus of the kind comprises at least one spindle with rotary locking, whose axis extends in parallel relationship with the axis of the metering apparatus and which is disposed in the region of the peripheral surface of the apparatus. The spindle is automatically driven by way of a transmission assembly when the metering apparatus is actuated. The number of metering portions already discharged and the number of metering portions permitted in total is quasi-continuously displayed by the mechanical counter. The transmission ratio of the transmission assembly can be designed to cover a wide range. The counter serving for display purposes can be reset on the spindle. The permissible period of use of a metering apparatus which can be used for a plurality of supply containers can be reliably viewed.

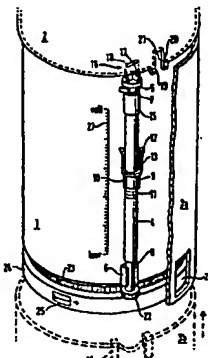


FIG. 1

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spindle is a cursor with rotary locking (prevention of rotation), a scale being disposed opposite same.  
[0013] According to another aspect, the invention provides a metering apparatus having two co-axially arranged housing portions which are rotatable relative to each other when the metering apparatus is operated, the metering apparatus having a mechanical counter comprising a screwthreaded spindle mounted in bearing means on one of the housing portions in a peripheral region thereof so that it is rotated by movement of the other housing portion, and a cursor movable by the screwthreaded spindle, relative to metering means, the arrangement being such that movement of the cursor with respect to the metering means provides a measure of the number of operations of the apparatus.  
[0014] Preferred features of the counter and the metering apparatus will now be described.  
[0015] The two housing portions are related relative to each other to actuate the metering apparatus. The angle of rotary movement may be a preferably integral fraction of 360 degrees; it is preferably 30 to 300 degrees. The relative movement of the first housing portion relative to the second housing portion, which is converted into a rotary movement of the spindle and a sliding movement of the cursor by means of the transmission assembly which comprises the tooth arrangement at the one end of the spindle and the at least one projection at the edge of the second housing portion. The rotary movement of the spindle is preferably in the form of a screwthreaded spindle. The transmission ratio of the projection-type transmission assembly is fixed by the number of projections and the number of teeth on the spindle; this also fixes the number of revolutions of the spindle, which corresponds to an actuation of the metering apparatus. For each actuation of the metering apparatus the number of revolutions of the spindle can be from 1/1000 (one thousandth) to 10. The pitch of the screwthread on the spindle is adapted to the number of metering portions which are to be taken from the supply container in the metering apparatus, and to the travel of the cursor on the spindle. When the spindle is rotated the cursor is displaced relative to the scale which is disposed for example on the first housing portion. The scale is preferably linearly divided. The position of the cursor indicates what proportion of the substance to be metered has already been taken from the supply container and what proportion is still present. The direction of rotation of the screwthread on the spindle is either in the same direction or in the opposite direction to the direction of rotation of the housing portions relative to each other.  
[0016] The cursor automatically comprises a display ring, at least one line having a screwthreaded portion and at least one further line with a recessed projection. There are preferably a plurality of lines and the lines are preferably of a rectangular form. The screwthreaded portion positively locking engages into the screwthread on the spindle. The cursor can be displaced on the spindle for resetting thereof, by means of the resetting projection. When the cursor is displaced the screwthreaded portion on the metering means also rotates over the spindle screwthreaded portion, so that the cursor and the housing are so selected that the cursor is prevented from being rotated on the spindle, by positively locking engagement. For example at least one of the resetting projections may project beyond the screwthreaded in such a degree that it does not pass through the gap between the spindle and the peripheral surface of the first housing portion. This projection serves as a rotary securing means for the cursor.  
[0017] A recess can be provided at the other end of the spindle which is in opposite relationship to the drive portion of the spindle. As soon as the screwthreaded portion on the metering means has reached that recess the cursor ceases to be displaced. The recess serves as a two-motion means for the cursor so that damage to the cursor is avoided if the screwthreaded travel distance of the cursor on the spindle is exceeded upon further actuation of the metering apparatus.  
[0018] Preferably a cover can be fixed over the first housing portion to protect the metering apparatus and the counter. The cover is connected to the first housing portion releasably in an axial direction in a pre-determined position. The cover when in the condition of being fixed in position cannot rotate relative to the first housing portion. Accordingly the first housing portion can still be rotated with respect to the second housing portion although the first housing portion is covered by the cover.  
[0019] The scale which is disposed opposite the cursor is provided either on the first housing portion or on the inside or the outside of the cover. The cover is transparent in a region-wise manner or it comprises transparent material.  
[0020] At least one rigid restraint means may be provided on the inside of the cover, which restraint means pushes the cursor back into the starting position thereof at the one end of the scale by means of the resetting projections when the cover is fixed into place.  
[0021] Elastic restraint means may be provided in place of the rigid restraint means. In this case the resetting projections of the cursor can be provided with spring means.  
[0022] When the cursor is reset the cursor stops against a stop at the one end of the scale before the cover reaches its end position. The cover is further moved to its end position, in which case the elastic restraint means is to keep the metering means in the elastic restraint means. Springs lock and the cursor and the restraint means are unlocked. Accordingly the cursor is at its starting position from which it is displaced when the spindle is rotated.  
[0023] In a specific configuration of the counter the spindle is a specific configuration of the counter the spindle is at the one end of the spindle has two levels of which one oppositely disposed teeth are wider than the other two teeth. Provided on the edge of the second housing portion are two projections, between which

there is a recess in which the wider teeth of the piston can sit. This transmission assembly preferably has a transmission ratio of half a spindle revolution to two rotations of the metering apparatus, for example half a revolution to a rotary movement of 360 degrees of the two housing portions relative to each other.  
[0024] If a rotational movement of for example 120 degrees of the two housing portions relative to each other is required for actuation of the metering apparatus there may be three projections on the second housing portion, more specifically being displaced through 120 degrees relative to each other. Furthermore in this case also the piston on the first housing portion is provided with three teeth, which are further related only in each third actuation of the metering apparatus, although each actuation is counted.  
[0025] The flanks of the wider teeth lie on the inner or outer peripheral surface of the second housing portion. The spindle is therefore rotatable only when the wider teeth can engage into the opening between the projections. That rotary locking arrangement always holds the spindle in the starting position which is provided at the beginning of the rotary movement.  
[0026] A plurality of supply containers containing the substance to be metered can possibly be successively fixed into the metering apparatus and used. If the substance to be metered is for example a medicament it may be necessary for reasons of hygiene to limit the permitted number of metering portions with the re-usable metering apparatus. Then it is additionally necessary to count and display the total number of metering portions which have already been discharged with the metering apparatus or the total number of metering portions which are still available. The above-described mechanical counter can be developed in various ways to cover this situation.  
[0027] In a first embodiment of such a development a gear is provided on the outer end of the spindle, which is provided with a series of teeth. Provided at the corresponding end of the first housing portion is a coaxial ring gear, preferably with a flange, which is mounted rotatably with respect to the first housing portion and into which the gear engages. The ring gear is also rotated through a given angle for each revolution of the spindle.  
[0028] Provided on the flange is at least one first clark which, after less than a 360 degree rotation of the ring gear relative to the first housing portion and after consumption of a supply container is disposed opposite a second mark which is in a fixed position relative to the first housing portion. The number of marks on the flange is equal to the number of supply containers which are permitted as a maximum for the metering apparatus (or for the substance to be metered). The second mark can be disposed on the first housing portion or it can be a window in the cover which is fixed onto the first housing portion.  
[0029] The flange can be provided, instead of the marks, with a scale which quasi-continuously displays

the total number of metering portions discharged with the metering apparatus or the total number of metering portions still available, for example in a window. The ring gear is rotated through at least 360 degrees to display the maximum permissible metering portions. For that purpose, a high stop-rate is possibly required between the rotation of the spindle and the rotation of the ring gear, this ratio being determined by means of a suitable ratio between the numbers of teeth involved.  
[0030] In a second embodiment of the development of the counter the counter includes a second spindle which may be similar to and arranged parallel to the first spindle and which carries a second scale, which is possibly resettable. Provided at one of the two ends of the first spindle is a gear which engages into a gear at the corresponding end of the second spindle. Disposed opposite the cursor on the spindle is a scale in a fixed position with respect to the first housing portion, which scale can be displaced either on the first housing portion or on the cover fixed thereon. In the case of the counter the total number of metering portions which have already been discharged or the total number of metering portions which are still available is represented on the displacement travel of the cursor on the second spindle.  
[0031] In place of the second spindle with gears, the arrangement may have a rotatably mounted roller, on the periphery of which a radial line is drawn with an entire revolution over the entire length of the roller. The surface on the two sides of the radial line are marked in different ways, preferably in two colours, for example red and white or red and green. In this construction the cover has a narrow window which is as long as the roller and through which a narrow strip of the peripheral surface of the roller is visible. A scale can be disposed inside the window and extends over the entire length of the roller. The scale can be divided in accordance with the maximum permitted number of metering portions or it can be divided into numbered sections according to the maximum permitted number of supply containers.  
[0032] A third embodiment of the development of the counter has a second spindle which is of a similar design configuration to the first spindle but which is disposed at another location in the region of the peripheral surface of the metering apparatus. It is provided with a transmission ratio, preferably in the first spindle, but the transmission ratio is matched to the total number of permissible metering portions. This spindle is driven by projections at the edge of the second housing portion, preferably by the projections which are already used for driving the first spindle.  
[0033] In order to provide the high stop-rate which is possibly required between the first and second scales or between the first spindle and the ring gear, the arrangement may have, instead of the gear on the first spindle, a single-clash transmission arrangement with which the gear on the second spindle of the ring gear is further rotated by two teeth for each revolution of the first spindle. The stop-rate can be from 2 to 1 to 10

Description

[0001] The invention concerns a mechanical counter for a metering apparatus for metering powders, liquids or gaseous substances, and metering apparatus comprising such a counter. The apparatus comprises two co-axially arranged housing portions which are rotated relative to each other upon actuation of the apparatus. The number of metering portions of the substance is counted and displayed by the counter.  
[0002] An aim of the invention is to provide optimum adaptation of a counter of that kind to handling of the metering apparatus in an operationally reliable manner, and to simplify manufacture of the counter.  
[0003] The invention has been particularly, though not exclusively, developed for application to metered dose inhalers (MDIs) such as are disclosed in US Patent 5427844 (derived from WO/81/0484), the entire contents of both of which are incorporated herein by reference. Pressure (generally at least 50 psi) is generated in a metered amount of fluid which is discharged through a nozzle assembly having one or more very small openings e.g. in the range 25 to 500 square micrometres. Preferred nozzle assemblies are disclosed in US Patent 5471143 (and parallel WO/84/07807), the entire contents of both of which are incorporated herein by reference. An energy storage means, such as a spring, is preferably manually loaded e.g. by a rotary screwthread arrangement as disclosed in US Patent 4280032 and GB Patent Application 2291133, the entire contents of both of which are incorporated herein by reference. A locking mechanism is generally provided to hold the spring in the loaded position and is manually releasable to pressurise the metered amount of fluid e.g. using a piston and cylinder arrangement. A reservoir and valve arrangement can be provided for recharging the cylinder. Further details are described in PCT/EP/96/04351 and parallel US/58/72218, the entire contents of both of which are incorporated herein by reference.  
[0004] Metering apparatuses are used for example in medical aerosol therapy for dealing with ailments of the respiratory tract. In this situation a liquid or powder medicament is converted to form an aerosol by means of an atomiser or entrained into a stream of gas. The medicament is contained in a supply container which is inserted into the metering apparatus. The supply is a container may be sufficient for several days up to some months. It is therefore necessary to display the consumed amount of medicament or the amount of medicament which is still present in the container.  
[0005] PCT Patent Publication WO/80/24167 provides a display device for a medical metering apparatus. This display device comprises a ring which is rotatable in a controlled relationship with respect to the apparatus and which, for each dose of a medicament under pressure which is taken from the metering apparatus, is automatically rotated through a predetermined angle by a wedge drive, a small portion of the ring being visible. The display device is pneumatically actuated when the medicament is inhaled.  
[0006] US Patent No. 4 817 822 discloses a display device for a metering apparatus, the display device comprising a linear or a rotatable disc-like scale which is disposed behind the metering device and which is moved by means of a locked wheel and a locking pawl. Only a small portion of the scale is visible through a window.  
[0007] PCT Patent Publication WO/86/05381 describes a display device for a metering apparatus, which device comprises a disc-like scale with teeth on the periphery of the disc, and is rotated by means of a ball member. Only a small portion of the scale is visible through a window.  
[0008] PCT Patent Publication WO/89/0324 discloses a display device for a metering apparatus in which the axial movement of the supply container within the housing is transmitted by means of a locking pawl and a worm gear to a rotatable scale of which a small portion is visible through a window.  
[0009] In accordance with PCT Patent Publication WO/96/02276 a display device for a medical spray apparatus comprises a digital mechanical counter which is actuated by the movement of the supply container within the housing as soon as a dose of the substance is taken from the supply container. This apparatus comprises a large number of individual parts.  
[0010] A display device which is actuated pneumatically or mechanically upon displacement of the supply container, which is under pressure, in the housing of the metering apparatus, is unsuitable for a metering apparatus having two housing portions which are rotatable relative to each other and a supply container which is loaded in the metering apparatus.  
[0011] Ways were therefore sought of providing a suitable mechanical counter for a metering apparatus having two housing portions which are rotatable relative to each other.  
[0012] The invention provides according to one aspect, a mechanical counter for a metering apparatus having two co-axially arranged housing portions which are rotatable relative to each other, which includes at least one spindle, whose axis extends substantially parallel to the axis of the metering apparatus, and which is disposed in the region of the peripheral surface of the metering apparatus and which is mounted in the first housing portion in the vicinity of the rotating shaft of the metering apparatus. The spindle is provided with a series of teeth, which are further related only in each third actuation of the metering apparatus, although each actuation is counted.  
[0013] The flanks of the wider teeth lie on the inner or outer peripheral surface of the second housing portion. The spindle is therefore rotatable only when the wider teeth can engage into the opening between the projections. That rotary locking arrangement always holds the spindle in the starting position which is provided at the beginning of the rotary movement.  
[0014] A plurality of supply containers containing the substance to be metered can possibly be successively fixed into the metering apparatus and used. If the substance to be metered is for example a medicament it may be necessary for reasons of hygiene to limit the permitted number of metering portions with the re-usable metering apparatus. Then it is additionally necessary to count and display the total number of metering portions which have already been discharged with the metering apparatus or the total number of metering portions which are still available. The above-described mechanical counter can be developed in various ways to cover this situation.  
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[0016] Provided on the flange is at least one first clark which, after less than a 360 degree rotation of the ring gear relative to the first housing portion and after consumption of a supply container is disposed opposite a second mark which is in a fixed position relative to the first housing portion. The number of marks on the flange is equal to the number of supply containers which are permitted as a maximum for the metering apparatus (or for the substance to be metered). The second mark can be disposed on the first housing portion or it can be a window in the cover which is fixed onto the first housing portion.  
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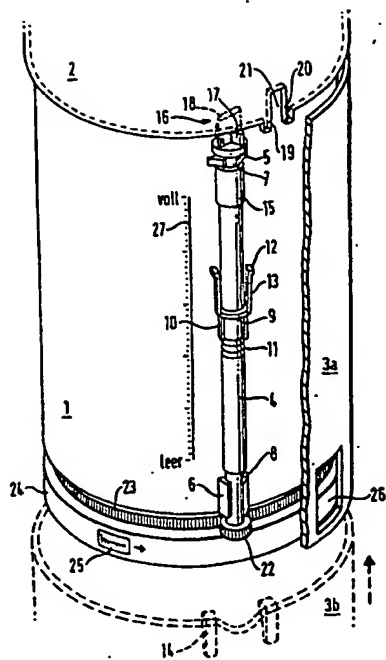


FIG. 1